SOLAR/2017-79/05

Monthly Performance Report

ALABAMA POWER COMPANY

MAY 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

MONTHLY PERFORMANCE REPORT

ALABAMA POWER COMPANY

MAY 1979

I. SYSTEM DESCRIPTION

The Alabama Power Company solar energy site is a two and one-half story commercial office building located in Montevallo, Alabama. The building has a floor area of approximately 17,000 square feet. The solar energy system is designed to provide 57 percent of the annual domestic hot water and space heating demands and up to 18 percent of the annual space cooling demand.

The collector subsystem includes four rows of flat plate double glazed collectors. The gross area of the collectors is 2,340 square feet. The collectors are supplemented by two types of reflectors. The rear three rows of the collectors have facing mirrors sloped at 45 degrees from the horizontal while the collectors are sloped at 30 degrees from the horizontal, facing south. All four rows of collectors have vertical mirrors mounted at the tops of the collector frames. The total area of the sloped reflectors is 2,250 square feet and the total area of the vertical reflectors is 740 square feet. The collection transport fluid is water and a drain down method of freeze protection is used. An 8,000 gallon tank is used to store solar energy.

Domestic hot water (DHW) preheating is accomplished by means of a heat exchanger tube passing through the solar storage tank. Solar preheating is supplemented, as required, by a 120-gallon electric water heater.

There are seven independently controlled heating/cooling zones. Each zone is supplied by its own air-handling unit. The air handling units have both hot and cold water lines to allow each unit to be used and controlled independently of the other six parallel units.

Space heating is provided by pumping water from the solar storage tank through heating coils in the air-handling units. The water from solar storage is passed through an electric auxiliary boiler prior to entering the coils of the air-handling units. If the water temperature in the

solar storage tank is too low to meet the heating demand, the electric boiler is used to provide additional heating to the water, as required.

Solar energy used in cooling is provided by passing water directly from the collectors to the generator section of a 25-ton absorption chiller. Auxiliary cooling is provided by a 30-ton electric reciprocating chiller which is used in parallel with the absorption machine. An 8,000-gallon chilled water storage tank is also included in the system. This chilled water storage tank can be supplied by the absorption machine or by the reciprocating chiller during off-peak hours.

The system, shown schematically in Figure 1, has four modes of solar operation.

Mode 1 - Collector to Storage: This mode is enabled by a time clock during daylight hours and it is entered when the temperature of the water at the collector outlet exceeds the temperature of the water in the solar storage tank by approximately 10°F. This temperature differential is adjustable and is to be adjusted for optimum performance based on operational experience. The mode is terminated when the collector outlet temperature no longer exceeds the storage tank temperature by the adjusted value or when the time clock disables the mode logic.

Mode 2 - Collector to Cooling: This mode is entered out of Mode 1 when the collector outlet water temperature reaches or exceeds 165°F. Water from the collectors is diverted directly to the generator section of the absorption chiller before returning to solar storage. Evaporator outlet water is passed to the cooling coils in the air handlers whenever a cooling demand exists. If no cooling demand exists during this mode, the chilled water from the absorption machine passes into the chilled water storage tank. In this mode, the absorption machine functions in parallel with the electric chiller to supply the building cooling load. Since heating and cooling are independently controlled by each zone, it is possible to have this mode and Mode 3 active simultaneously. The mode is terminated when the absorption machine generator inlet water temperature drops to 157°F.

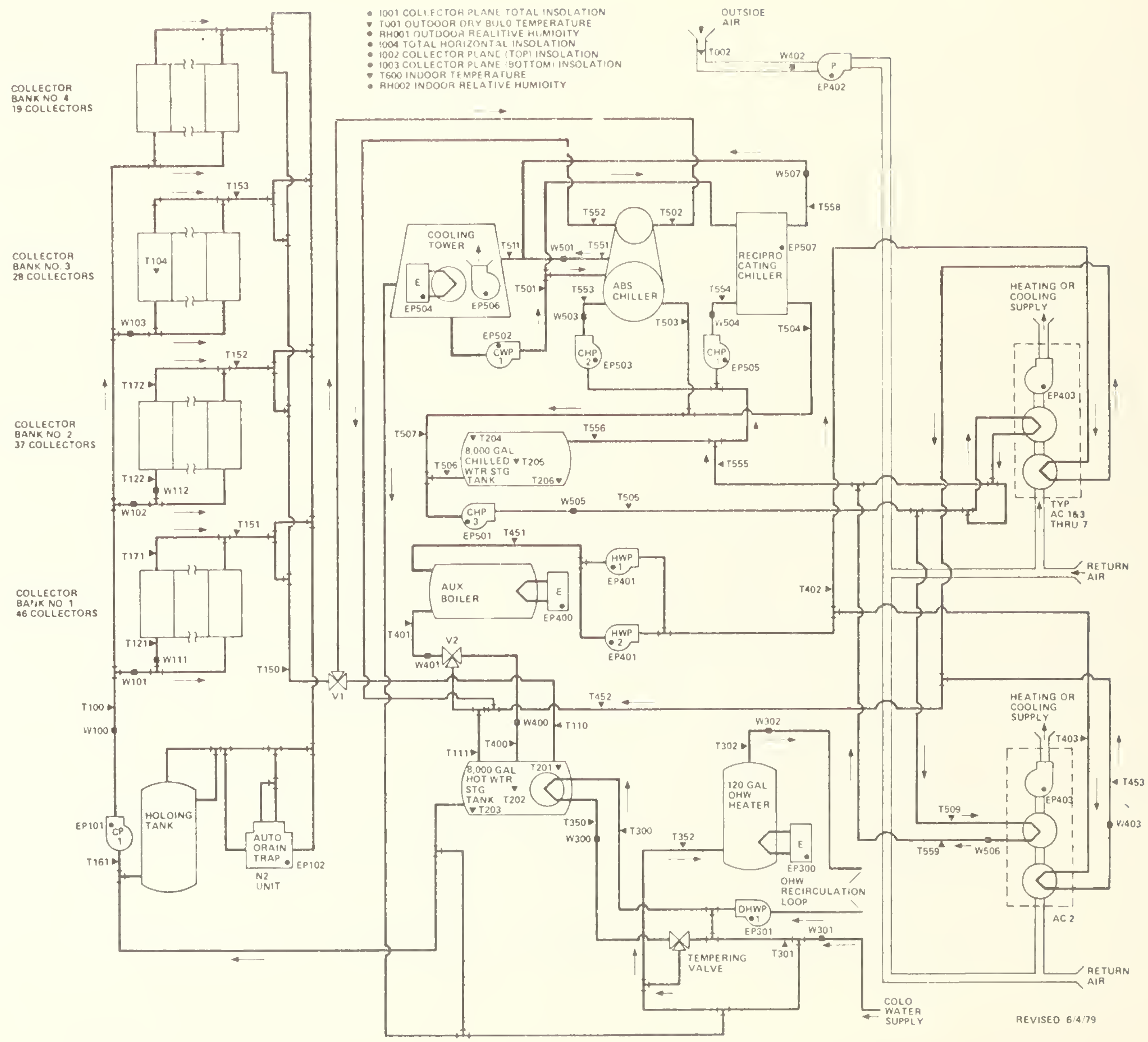

Figure 1. ALABAMA POWER SOLAR ENERGY SYSTEM SCHEMATIC

Mode 3 - Storage to Space Heating: This mode is initiated when a demand for space heating occurs at any of the independently controlled heating/cooling zones or when the outdoor air temperature drops below 65°F. Water from the solar storage tank is pumped through the auxiliary boiler, out to the air handling units and returned to storage. If the temperature of the water in the solar storage tank is above the limit value of 140°F, blending of solar storage water and space heating return water occurs to maintain a boiler inlet water temperature below 140°F. The minimum control temperature for space heating supply is varied with outside air temperature. When the outside air temperature is 65°F, the minimum space heating water temperature is 80°F. When the outside air temperature is 25°F, the minimum space heating water temperature is 120°F. The boiler is activated, as required, to maintain the minimum space heating temperature according to the control temperature just described. If the solar storage tank temperature is below the temperature of the space heating return water, the solar storage tank is bypassed by the return water. This mode can be active simultaneously with Mode 2 since heating and cooling demands are independently determined by each of the heating/cooling zones.

Mode 4 - DHW Preheating: This mode is accomplished independently of the other three solar modes. Incoming city (makeup) water and recirculation return water are passed through a U-tube heat exchanger in the solar storage tank when the temperature of the water in storage exceeds the DHW heat exchanger inlet water temperature. From the heat exchanger the water returns to the 120-gallon DHW tank which contains an electric auxiliary heating element to supplement the solar preheat. Water from the DHW tank is continuously recirculated through the building's hot water lines and returned to the DHW tank via the heat exchanger or directly.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data.

The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The Alabama Power Company solar energy site was in operation during the entire month of May. The solar energy system supplied approximately three percent of the combined loads for DHW, space heating and space cooling. Space cooling was the primary load for the month but none of this load was supported by solar energy since the solar heated water was not hot enough to support absorption cooling.

B. Weather

The average ambient temperature for May was 69°F with an average daytime ambient temperature of 73°F. The long-term average temperature for May is 70°F for the Birmingham, Alabama area. With these mild temperatures, the heating and cooling loads are expected to be small for May. The total incident insolation on the collector array was 110.09 million Btu for an average of 1,518 Btu/ft^2-day. This was below the May average of 1,896 Btu/ft^2-day derived from long-term data for the Birmingham area.

C. System Thermal Performance

Collector - Of the 110.09 million Btu of solar energy incident upon the collector array during May, 71.45 million Btu were incident when the collector pump (CP1) was operating. The system produced a net collection of 13.04 million Btu, which was 12 percent of the total incident radiation. The net collection of 13.04 million Btu was the result of 18.49 million Btu measured gain through the collectors reduced by a measured rejection of 5.45 million Btu. The relatively high level of energy rejection through the collectors was the result of frequent operation of the collector pump at times when insolation was too low for collection. The operating energy (collector pump power) for the collector subsystem was 2.22 million Btu during May.

Energy Collection and Storage Subsystem - The energy collection and storage subsystem (ECSS) includes the collector array, the solar storage tank and the lines connecting these elements to each other. The ECSS is connected to the load subsystems by supply and return lines. Figure 2 illustrates the ECSS and its energy flow paths. The net input to the ECSS through the collectors was 13.04 million Btu (18.49 million Btu collected, less 5.45 million Btu rejected). The output from the ECSS to the load subsystem connecting lines was 4.63 million Btu and the stored energy level experienced a drop of 0.61 million Btu. Therefore, the total loss of energy from the connecting lines and solar storage tank was 9.02 million Btu.

Storage - The measured input to the solar storage tank was 17.79 million Btu while solar energy was being collected. The total measured output from the solar storage tank was 8.61 million Btu. The measured temperature in the solar storage tank indicated a decrease of 0.61 million Btu in stored energy for the month. Therefore, the calculated loss through the walls of the storage tank was 9.79. The discrepancy between the loss in the storage tank walls and the total ECSS system losses will be discussed in the observations.

Domestic Hot Water Load - The DHW load calculation is based on the flow through the DHW heat exchanger and the temperature difference between the outlet and inlet of the DHW heat exchanger plus the auxiliary electrical energy input to the DHW heater tank. The average temperature maintained at the DHW tank outlet was 123°F during May. The total DHW load for the month was 1.72 million Btu, 90 percent of which was supplied by solar energy. Due to the nature of the DHW subsystem and the lack of measurement of the incoming cold water supply volume, this load includes both consumption and sustaining (loss) loads within the recirculating DHW subsystem. Since the operating energy in the DHW subsystem is due solely to the recirculating pump, no operating energy is charged directly to the solar energy system for DHW support.

Space Heating Load - The total measured space heating load for May was 1.21 million Btu, of which 1.16 million Btu, or 96 percent, were supplied by solar energy. The remaining 0.05 million Btu were supplied by the

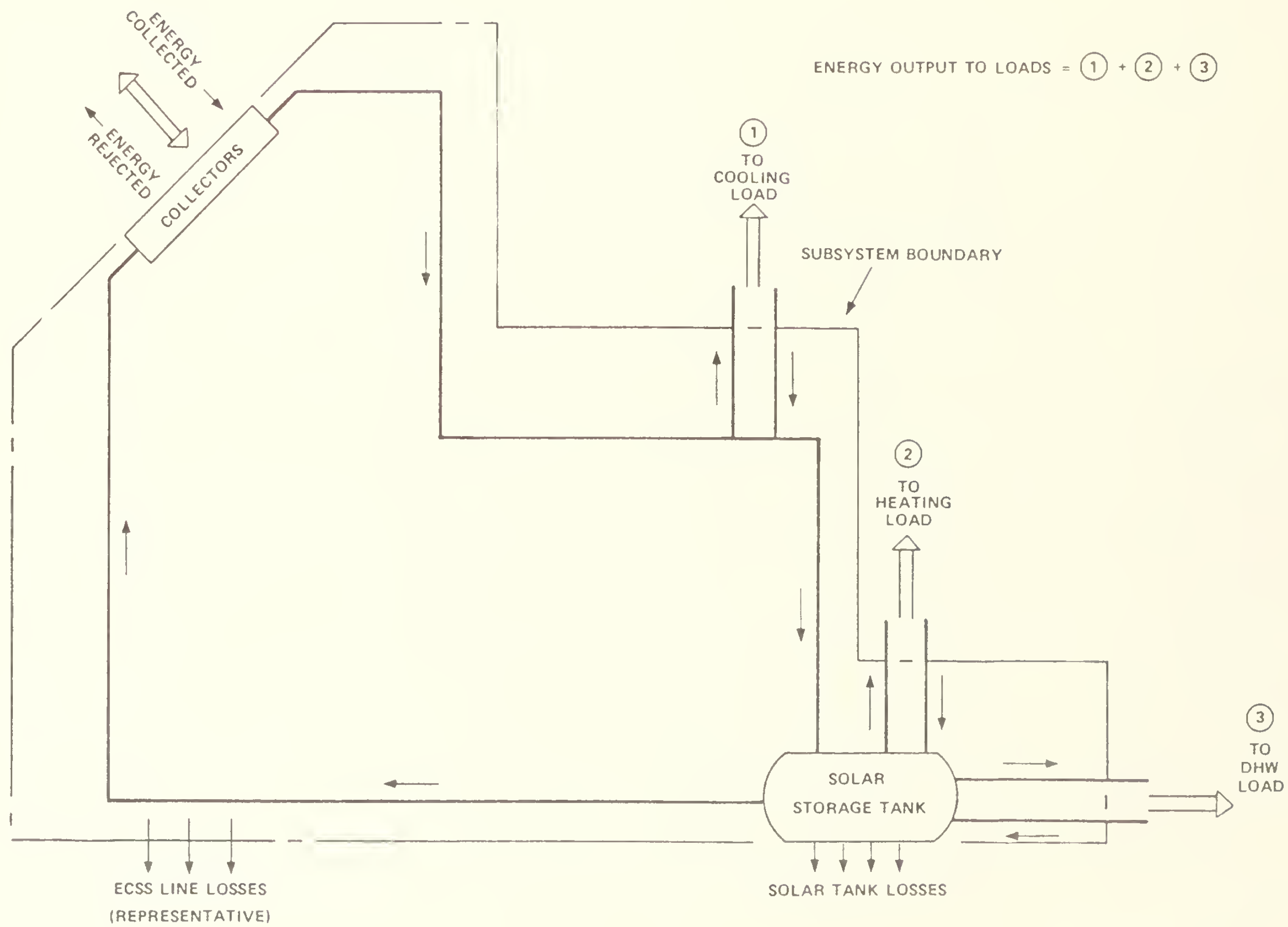

Figure 2. ALABAMA POWER COMPANY ECSS ENERGY FLOW SCHEMATIC

electric boiler. The total operating energy for the space heating subsystem was 0.17 million Btu of which 0.10 million Btu were charged directly to the solar energy system. The operating energy charged directly to the solar energy system was the pro-rata share of the circulation pump (HWP1, HWP2) power required to circulate the heated water through the space heating subsystem. Power to operate the air-handler fans was not charged against solar energy since that power would have been required regardless of whether a conventional or solar energy system was used.

Space Cooling Load - The total space cooling load for May was 85.04 million Btu. A negligible amount of this load was supported by solar energy due to the low temperature of the solar heated water available at the absorption chiller generator inlet. The absorption chiller was active on four days for a short period of time and the operating energy for space cooling charged to the solar energy system was 0.25 million Btu. The operation of the auxiliary electric chiller is summarized in the table entitled "Auxiliary Thermodynamic Conversion Equipment."

D. Observations

A significant penalty was imposed on the solar energy system by the high percentage of energy rejected through the collectors. The space cooling mode of solar energy system suffered considerably, since the water temperature in the storage tank was not raised sufficiently to activate the absorption chiller. Control system improvements and basic repairs are needed to optimize solar energy collection and minimize rejection of energy through the collectors.

The seemingly high energy losses in the hot water storage tank are due to two factors. The first is the expected losses from the tank with two inches of polyurethane insulation. This calculates to be approximately 3.3 million Btu. Secondly, due to the placement of the collector control

sensor, collector pumps were activated every half-hour in the morning to determine an accurate collector outlet temperature. During the course of the month, this resulted in a rejection of approximately 6.5 million Btu of energy from the storage tank. Since this amount can only be determined indirectly, it does not enter into calculations for losses in the storage tank walls, giving an appearance of a greater loss from the storage tank walls than from the entire ECSS. This also explains why the storage tank temperature dropped 11°F when it appears that is should have gained energy. This difficulty is only temporary, since the collector control sensor should be relocated before August 1979.

E. Energy Savings

A total electrical savings of 0.30 million Btu was calculated for the Alabama Power Company solar energy system. The savings calculations for DHW and space heating are based on the assumption that all load support provided by solar energy would have been provided by an equal amount of electrical energy. This load support is reduced by the amount of operating energy charged to solar hot water heating and solar space heating. The space cooling savings are calculated by obtaining the quotient of the load supplied by the absorption chiller divided by the coefficient of performance of a typical electric chiller (2.8) and subtracting the operating energy charged to solar (absorption) cooling. The total system savings is then calculated by summing the subsystem savings and reducing that sum by the amount of operating energy required by the ECSS.

III. ACTION STATUS

None.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL — SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

SITE/SYSTEM DESCRIPTION:
ALABAMA POWER SOLAR SYSTEM PROVIDES SUPPORT TO SPACE HEATING, SPACE COOLING AND DOMESTIC HOT WATER SYSTEMS. SOLAR HEATED WATER IS UTILIZED TO DRIVE AN ABSORPTION CHILLER WHICH ASSISTS AN ELECTRIC POWERED CHILLER IN PROVIDING SYSTEM COOLING WATER. HEATED WATER FOR SUPPORTING SPACE HEATING AND DOMESTIC HOT WATER IS STORED IN AN 8000 GALLON CAPACITY TANK. THE DOMESTIC HOT WATER CONTINUOUS RECIRCULATION LOOP INCLUDES FLOW THROUGH A HEAT EXCHANGER LOCATED INSIDE THE STORAGE TANK.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	110.091	MILLION BTU
	47048	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	13.039	MILLION BTU
	5572	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	69	DEGREES F
AVERAGE BUILDING TEMPERATURE	78	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.04	
ECSS OPERATING ENERGY	2.220	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	74.416	MILLION BTU
TOTAL ENERGY CONSUMED	111.486	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	1.720	1.212	85.042	87.229	MILLION BTU
SOLAR FRACTION	90	96	0	3	PERCENT
SOLAR ENERGY USED	1.558	1.159	2.189	4.180	MILLION BTU
OPERATING ENERGY	0.442	0.166	71.375	74.416	MILLION BTU
AUX. THERMAL ENERGY	0.162	0.053	15.386	15.583	MILLION BTU
AUX. ELECTRIC FUEL	0.162	0.053	21.980	22.177	MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A.	MILLION BTU
ELECTRICAL SAVINGS	1.558	1.132	-0.171	-0.627	MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A.	MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.271

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL — SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	116.146	GIGA JOULES
	534272	KJ/SQ.M.
COLLECTED SOLAR ENERGY	13.756	GIGA JOULES
	63276	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	21	DEGREES C
AVERAGE BUILDING TEMPERATURE	25	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.04	
ECSS OPERATING ENERGY	2.342	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	78.508	GIGA JOULES
TOTAL ENERGY CONSUMED	117.618	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	1.815	1.279	89.719	92.027	GIGA JOULES
SOLAR FRACTION	90	96	0	3	PERCENT
SOLAR ENERGY USED	1.643	1.223	2.310	4.410	GIGA JOULES
OPERATING ENERGY	0.466	0.175	75.301	78.508	GIGA JOULES
AUX. THERMAL ENG	0.171	0.056	16.233	16.440	GIGA JOULES
AUX. ELECTRIC FUEL	0.171	0.056	23.189	23.397	GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A.	GIGA JOULES
ELECTRICAL SAVINGS	1.643	1.195	-0.181	-0.661	GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A.	GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.271

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL
REPORT PERIOD: MAY,1979

SOLAR/2017-79/05

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	4.713	64	0.304	N	0.117	N	0.065
2	3.323	70	0.000	O	0.111	O	0.000
3	2.585	72	0.003	T	0.099	T	0.000
4	0.835	67	0.000		0.081		0.000
5	3.164	68	0.002	A	0.000	A	0.001
6	3.554	66	0.000	P	0.001	P	0.000
7	4.237	69	0.000	P	0.115	P	0.000
8	2.752	71	0.004	L	0.113	L	0.001
9	3.375	75	0.090	I	0.104	I	0.032
10	3.619	76	0.115	C	0.105	C	0.034
11	3.453	77	0.081	A	0.095	A	0.023
12	2.960	71	0.064	B	0.045	B	0.021
13	1.226	61	0.098	L	0.000	L	0.080
14	5.205	63	0.857	E	0.103	E	0.019
15	4.919	68	0.739		0.090		0.153
16	5.143	69	0.234		0.071		0.088
17	4.724	68	0.174		0.062		0.067
18	4.490	71	0.449		0.077		0.116
19	3.518	70	0.000		0.000		0.000
20	4.733	74	0.008		0.001		0.002
21	4.547	74	0.029		0.104		0.006
22	4.586	74	0.019		0.110		0.004
23	1.979	70	0.050		0.049		0.028
24	3.360	66	0.114		0.090		0.034
25	4.665	57	0.526		0.105		0.077
26	5.242	60	0.182		0.010		0.035
27	2.967	64	0.110		0.001		0.037
28	2.589	70	0.099		0.070		0.038
29	2.259	70	0.096		0.092		0.042
30	2.851	72	0.098		0.099		0.034
31	2.516	72	0.088		0.097		0.035
SUM	110.091	-	4.632	N.A.	2.220	N.A.	-
AVG	3.551	69	0.149	N.A.	0.072	N.A.	0.038
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	4.713	4.242	1.068	74	0.227
2	3.323	2.847	-0.069	73	-0.021
3	2.585	2.080	-0.010	74	-0.004
4	0.835	0.415	-0.748	68	-0.896
5	3.164	0.000	0.000	71	0.000
6	3.554	0.000	0.000	68	0.000
7	4.237	3.810	1.320	74	0.312
8	2.752	2.461	0.190	73	0.069
9	3.375	2.907	0.559	76	0.166
10	3.619	3.175	0.956	79	0.264
11	3.453	3.105	0.837	82	0.242
12	2.960	1.083	0.066	76	0.022
13	1.226	0.000	0.000	60	0.000
14	5.205	4.562	1.510	70	0.290
15	4.919	4.406	1.338	77	0.272
16	5.143	4.509	1.261	77	0.245
17	4.724	3.972	0.889	77	0.188
18	4.490	3.833	0.641	79	0.143
19	3.518	0.000	0.000	78	0.000
20	4.733	0.000	0.000	81	0.000
21	4.547	3.956	0.856	81	0.188
22	4.586	4.118	0.725	80	0.158
23	1.979	0.862	-0.261	69	-0.132
24	3.360	2.664	0.449	68	0.134
25	4.665	4.010	0.804	62	0.172
26	5.242	0.000	0.000	68	0.000
27	2.967	0.000	0.000	68	0.000
28	2.589	2.037	0.210	69	0.081
29	2.259	1.864	0.087	70	0.038
30	2.851	2.473	0.338	76	0.118
31	2.516	2.062	0.025	76	0.010
SUM	110.091	71.454	13.039	-	-
AVG	3.551	2.305	0.421	73	0.118
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	1.268	0.505	0.626	139	0.892
2	0.436	0.505	-0.203	144	0.692
3	0.293	0.306	-0.385	139	-0.272
4	0.000	0.748	-1.125	129	1.000
5	0.000	0.002	-0.123	119	1.000
6	0.000	0.000	-0.038	117	1.000
7	1.355	0.035	0.981	122	0.750
8	0.385	0.199	-0.093	130	0.275
9	0.674	0.205	0.229	131	0.644
10	1.037	0.197	0.533	136	0.704
11	0.996	0.239	0.287	144	0.529
12	0.202	0.201	-0.334	145	-0.658
13	0.000	0.098	-0.266	141	1.000
14	1.510	0.857	0.587	138	0.956
15	1.353	0.304	0.666	150	0.717
16	1.117	0.039	0.504	159	0.486
17	0.810	0.013	-0.004	163	0.010
18	0.571	0.256	-0.172	163	0.146
19	0.000	0.000	-0.369	161	1.000
20	0.000	0.008	-0.286	155	1.000
21	1.075	0.248	0.213	152	0.429
22	1.023	0.317	0.273	156	0.577
23	0.040	0.351	-1.143	150	-19.715
24	0.620	0.285	-0.144	139	0.228
25	0.870	0.521	0.321	141	0.968
26	0.000	0.182	0.211	146	1.000
27	0.000	0.110	-0.469	145	1.000
28	0.575	0.463	-0.419	135	0.078
29	0.520	0.530	-0.297	131	0.447
30	0.577	0.338	0.034	129	0.644
31	0.481	0.544	-0.204	128	0.707
SUM	17.789	8.605	-0.607	-	-
AVG	0.574	0.278	-0.020	141	0.450
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL — SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.017	29	0.005	0.000	0.012	0.012	N	0.005	N	66	105	N
2	0.006	0	0.000	0.000	0.006	0.006	O	0.000	O	70	101	O
3	0.024	13	0.003	0.000	0.021	0.021	T	0.003	T	70	91	T
4	0.024	0	0.000	0.000	0.024	0.024		0.000		70	94	
5	0.025	10	0.002	0.000	0.023	0.023	A	0.002	A	74	104	A
6	0.023	0	0.000	0.000	0.023	0.023	P	0.000	P	73	105	P
7	0.021	0	0.000	0.000	0.021	0.021	P	0.000	P	71	105	P
8	0.027	15	0.004	0.000	0.023	0.023	L	0.004	L	71	103	L
9	0.100	90	0.090	0.010	0.010	0.010	I	0.090	I	71	112	I
10	0.115	100	0.115	0.020	0.000	0.000	C	0.115	C	72	127	C
11	0.081	100	0.081	0.019	0.000	0.000	A	0.081	A	72	132	A
12	0.062	100	0.062	0.020	0.000	0.000	B	0.062	B	76	133	B
13	0.098	100	0.098	0.020	0.000	0.000	L	0.098	L	77	130	L
14	0.094	100	0.094	0.019	0.000	0.000	E	0.094	E	73	128	E
15	0.052	97	0.052	0.018	0.000	0.000		0.052		73	134	
16	0.009	100	0.009	0.018	0.000	0.000		0.009		73	137	
17	0.009	100	0.009	0.020	0.000	0.000		0.009		73	138	
18	0.013	100	0.013	0.020	0.000	0.000		0.013		73	138	
19	0.000	0	0.000	0.020	0.000	0.000		0.000		76	138	
20	0.008	100	0.008	0.019	0.000	0.000		0.008		77	137	
21	0.029	100	0.029	0.019	0.000	0.000		0.029		74	136	
22	0.019	100	0.019	0.020	0.000	0.000		0.019		75	137	
23	0.050	97	0.050	0.019	0.000	0.000		0.050		74	135	
24	0.114	100	0.114	0.020	0.000	0.000		0.114		74	130	
25	0.109	100	0.109	0.020	0.000	0.000		0.109		73	130	
26	0.100	100	0.100	0.020	0.000	0.000		0.100		74	131	
27	0.110	100	0.110	0.020	0.000	0.000		0.110		77	130	
28	0.099	100	0.099	0.020	0.000	0.000		0.099		75	127	
29	0.096	100	0.096	0.020	0.000	0.000		0.096		74	123	
30	0.098	100	0.098	0.020	0.000	0.000		0.098		73	122	
31	0.088	100	0.088	0.021	0.000	0.000		0.088		73	121	
SUM	1.720	-	1.558	0.442	0.162	0.162	N.A.	1.558	N.A.	-	-	N.A.
AVG	0.055	90	0.050	0.014	0.005	0.005	N.A.	0.050	N.A.	73	123	N.A.
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL — SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.300	100	0.299	0.036	0.001	0.001	N	0.293	N	76	64
2	0.000	0	0.000	0.000	0.000	0.000	O	0.000	O	77	70
3	0.000	0	0.000	0.000	0.000	0.000	T	0.000	T	77	72
4	0.000	0	0.000	0.000	0.000	0.000		0.000		77	67
5	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	79	68
6	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	80	66
7	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	77	69
8	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	77	71
9	0.000	0	0.000	0.000	0.000	0.000	I	0.000	I	76	75
10	0.000	0	0.000	0.000	0.000	0.000	C	0.000	C	76	76
11	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	77	77
12	0.000	0	0.000	0.000	0.000	0.000	B	0.000	B	79	71
13	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	80	61
14	0.785	97	0.763	0.000	0.022	0.022	E	0.751	E	76	63
15	0.000	0	0.000	0.000	0.000	0.000		0.000		76	68
16	0.000	0	0.000	0.000	0.000	0.000		0.000		76	69
17	0.000	0	0.000	0.000	0.000	0.000		0.000		78	68
18	0.000	0	0.000	0.000	0.000	0.000		0.000		77	71
19	0.000	0	0.000	0.000	0.000	0.000		0.000		81	70
20	0.000	0	0.000	0.000	0.000	0.000		0.000		84	74
21	0.000	0	0.000	0.000	0.000	0.000		0.000		79	74
22	0.000	0	0.000	0.000	0.000	0.000		0.000		78	74
23	0.000	0	0.000	0.000	0.000	0.000		0.000		77	70
24	0.000	0	0.000	0.000	0.000	0.000		0.000		77	66
25	0.031	48	0.015	0.025	0.016	0.016		0.013		76	57
26	0.097	85	0.082	0.104	0.015	0.015		0.075		77	60
27	0.000	0	0.000	0.000	0.000	0.000		0.000		80	64
28	0.000	0	0.000	0.000	0.000	0.000		0.000		77	70
29	0.000	0	0.000	0.000	0.000	0.000		0.000		76	70
30	0.000	0	0.000	0.000	0.000	0.000		0.000		76	72
31	0.000	0	0.000	0.000	0.000	0.000		0.000		76	72
SUM	1.212	-	1.159	0.166	0.053	0.053	N.A.	1.132	N.A.	-	-
AVG	0.039	96	0.037	0.005	0.002	0.002	N.A.	0.037	N.A.	78	69
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE COOLING SUBSYSTEM

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL — SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MON.	SPACE COOLING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG DRY BULB TEMP F	AMB TEMP DEG F
1	2.266	0	0.000	2.457	0.473	0.675	N	0.000	N	76	64
2	2.438	0	0.000	2.419	0.490	0.700	O	0.000	O	77	70
3	3.465	0	0.000	2.612	0.652	0.932	T	0.000	T	77	72
4	2.721	0	0.000	2.513	0.652	0.931		0.000		77	67
5	0.000	0	0.000	1.637	0.000	0.000	A	0.000	A	79	68
6	0.000	0	0.000	1.637	0.000	0.000	P	0.000	P	80	66
7	3.668	0	0.000	2.621	0.618	0.883	P	0.000	P	77	69
8	3.475	0	0.000	2.426	0.670	0.956	L	0.000	L	77	71
9	4.573	0	0.000	2.571	0.714	1.020	I	0.000	I	76	75
10	4.968	0	0.000	2.602	0.871	1.244	C	0.000	C	76	76
11	4.193	0	0.000	2.403	0.677	0.967	A	0.000	A	77	77
12	0.781	0	0.000	1.899	0.251	0.359	B	0.000	B	79	71
13	0.000	0	0.000	1.637	0.000	0.000	L	0.000	L	80	61
14	3.325	0	0.000	2.540	0.593	0.847	E	0.000	E	76	63
15	3.726	1	0.701	2.614	0.671	0.959		-0.026		76	68
16	4.362	1	0.440	2.721	0.771	1.102		-0.046		76	69
17	2.512	2	0.308	2.499	0.186	0.266		-0.074		78	68
18	3.622	1	0.506	2.495	0.783	1.119		-0.026		77	71
19	0.000	0	0.000	1.637	0.000	0.000		0.000		81	70
20	0.000	0	0.000	1.637	0.000	0.000		0.000		84	74
21	5.428	0	0.000	2.653	0.937	1.339		0.000		79	74
22	4.481	0	0.000	2.487	0.780	1.115		0.000		78	74
23	4.378	0	0.000	2.595	0.852	1.218		0.000		77	70
24	3.131	0	0.000	2.400	0.556	0.795		0.000		77	66
25	2.596	0	0.234	2.507	0.557	0.795		0.002		76	57
26	0.000	0	0.000	1.637	0.000	0.000		0.000		77	60
27	0.000	0	0.000	1.637	0.000	0.000		0.000		80	64
28	3.660	0	0.000	2.607	0.702	1.002		0.000		77	70
29	3.766	0	0.000	2.446	0.630	0.900		0.000		76	70
30	3.717	0	0.000	2.425	0.647	0.924		0.000		76	72
31	3.792	0	0.000	2.407	0.654	0.934		0.000		76	72
SUM	85.042	-	2.189	71.375	15.386	21.980	N.A.	-0.171	N.A.	-	-
AVG	2.743	0	0.071	2.302	0.496	0.709	N.A.	-0.006	N.A.	78	69
NBS	Q502	N500	Q500	Q503	Q501		Q508	Q512	Q514	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL
REPORT PERIOD: MAY,1979

SOLAR/2017-79/05

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	2014	N	64	74	N	N	N
2	1420	O	70	73	O	O	O
3	1105	T	72	74	T	T	T
4	357		67	68			
5	1352	A	68	71	A	A	A
6	1519	P	66	68	P	P	P
7	1810	P	69	74	P	P	P
8	1176	L	71	73	L	L	L
9	1443	I	75	76	I	I	I
10	1547	C	76	79	C	C	C
11	1475	A	77	82	A	A	A
12	1265	B	71	76	B	B	B
13	524	L	61	60	L	L	L
14	2225	E	63	70	E	E	E
15	2102		68	77			
16	2198		69	77			
17	2019		68	77			
18	1919		71	79			
19	1504		70	78			
20	2023		74	81			
21	1943		74	81			
22	1960		74	80			
23	846		70	69			
24	1436		66	68			
25	1993		57	62			
26	2240		60	68			
27	1268		64	68			
28	1107		70	69			
29	965		70	70			
30	1218		72	76			
31	1075		72	76			
SUM	47048	N.A.	-	-	-	-	-
AVG	1518	N.A.	69	73	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
THERMODYNAMIC CONVERSION EQUIPMENT

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	EQUIPMENT LOAD MILLION BTU	THERMAL ENERGY INPUT MILLION BTU	OPERATING ENERGY MILLION BTU	ENERGY REJECTED MILLION BTU	COEFFICIENT OF PERFORMANCE (SEE NOTE)
1	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000
15	0.025	0.701	0.036	0.026	0.036
16	0.056	0.440	0.069	0.036	0.128
17	0.040	0.308	0.090	0.028	0.130
18	0.060	0.506	0.050	0.170	0.118
19	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000
25	0.007	0.234	0.001	0.001	0.029
26	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000
SUM	0.188	2.189	0.246	0.260	0.086
AVG	0.006	0.071	0.008	0.008	0.003

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.
NOTE:

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
AUXILIARY STORAGE PERFORMANCE

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	INCREASE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.034	0.163	0.049	46	-0.089
2	0.079	0.259	-0.043	46	0.470
3	0.343	0.359	0.048	47	0.814
4	0.179	0.981	-0.435	45	0.626
5	0.092	0.000	0.120	42	1.000
6	0.000	0.000	0.123	44	1.000
7	0.811	0.996	0.358	51	0.455
8	0.182	0.611	-0.297	46	0.784
9	0.699	0.462	0.307	47	0.837
10	0.283	0.502	-0.325	46	1.212
11	0.329	0.067	0.329	48	-0.003
12	0.052	0.000	-0.114	49	1.000
13	0.022	0.000	0.074	48	1.000
14	0.075	0.287	-0.267	46	0.063
15	0.092	0.440	-0.055	45	0.334
16	0.138	0.447	0.014	45	0.259
17	1.855	0.023	1.263	56	26.144
18	0.132	1.080	-0.945	56	0.998
19	0.000	0.000	0.100	51	1.000
20	0.000	0.000	0.106	52	1.000
21	0.202	0.180	-0.097	53	1.662
22	0.148	0.217	-0.086	51	1.075
23	0.237	0.811	-0.448	47	0.872
24	0.188	0.350	0.097	45	0.258
25	0.113	0.547	-0.196	45	0.565
26	0.058	0.000	0.120	44	1.000
27	0.094	0.000	0.132	46	1.000
28	0.218	0.704	-0.275	44	0.700
29	0.231	0.251	0.106	44	0.498
30	0.186	0.323	-0.029	45	0.663
31	0.277	0.363	0.003	45	0.754
SUM	7.349	10.422	-0.264	-	-
AVG	0.237	0.336	-0.009	47	0.730

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
AUXILIARY THERMODYNAMIC CONVERSION EQUIPMENT

SITE: ALABAMA POWER COMPANY, MONTEVALLO, AL SOLAR/2017-79/05
REPORT PERIOD: MAY,1979

DAY OF MONTH	EQUIPMENT LOAD MILLION BTU	THERMAL ENERGY INPUT MILLION BTU	OPERATING ENERGY MILLION BTU	ENERGY REJECTED MILLION BTU	COEFFICIENT OF PERFORMANCE (SEE NOTE)
1	2.260	0.675	1.952	2.288	3.347
2	2.538	0.700	1.943	2.530	3.626
3	3.512	0.932	2.025	3.481	3.769
4	3.661	0.931	1.987	3.570	3.932
5	0.000	0.000	1.637	0.000	0.000
6	0.000	0.000	1.637	0.000	0.000
7	3.795	0.883	2.010	3.704	4.298
8	3.753	0.956	1.955	3.731	3.924
9	4.203	1.020	2.008	4.064	4.122
10	5.016	1.244	2.005	4.927	4.033
11	3.864	0.967	1.941	3.847	3.997
12	1.106	0.359	1.832	1.137	3.083
13	0.000	0.000	1.637	0.000	0.000
14	3.095	0.847	1.969	3.090	3.656
15	3.584	0.959	1.984	3.563	3.739
16	4.267	1.102	2.012	4.246	3.872
17	1.154	0.266	1.921	1.088	4.339
18	4.746	1.119	1.957	4.645	4.241
19	0.000	0.000	1.637	0.000	0.000
20	0.000	0.000	1.637	0.000	0.000
21	5.507	1.339	2.041	5.424	4.114
22	4.535	1.115	1.981	4.472	4.068
23	4.817	1.218	2.016	4.780	3.957
24	2.999	0.795	1.923	2.973	3.773
25	2.685	0.795	1.960	2.719	3.376
26	0.000	0.000	1.637	0.000	0.000
27	0.000	0.000	1.637	0.000	0.000
28	3.673	1.002	1.998	3.665	3.665
29	3.575	0.900	1.942	3.527	3.972
30	3.709	0.924	1.932	3.674	4.015
31	3.724	0.934	1.928	3.665	3.985
SUM	85.779	21.980	58.679	84.808	-
AVG	2.767	0.709	1.893	2.736	3.903

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.
NOTE: